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(54) IMPROVEMENTS IN OR RELATING TO THE AUTOMATIC CONTROL OF SAWING MACHINES

(71) We, COMPAGNIE WILLIAM GILLET-GUILLIET-RENNEPONT, a Societe Anonyme, organised and existing under the laws of France of Avenue J. F. Kennedy 33700, Marignac, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to methods and apparatus for controlling sawing machines.

With automatic machines for sawing various materials such as for example, wood, stone, plastics it is generally desired to initiate certain functions as soon as the sawing operation itself has come to an end. These functions may include return or lateral shift of a carriage carrying the workpiece just sawn.

Generally, the end of the cutting process itself is not directly detected but is sensed indirectly by making use of other functions which are associated with the cutting in a operational synchronous manner in the machine.

As a result, the commencement of the subsequent functions is inevitably initiated with a delay with respect to the end of the cutting operation giving rise to large and costly losses of time.

According to one aspect of the invention, there is provided a method of controlling a sawing machine including monitoring the sound generated by the sawing machine during idling and sawing and generating a monitored-sound signal of a magnitude indicative of the magnitude of at least one frequency component of the sound monitored, generating a completion signal upon the magnitude of the said monitored-sound signal becoming equal to a value indicative that sawing by the machine has been completed, and utilising said completion signal to control movement of a workpiece relative to a saw blade of the machine.

According to another aspect of the invention, there is provided apparatus for controlling a sawing machine including sound monitoring means for generating an electrical signal of a magnitude indicative of the magnitude of at least one frequency component of sound generated by the sawing machine during idling and sawing, and completion-signal generating means for generating a completion signal upon the magnitude of the said electrical signal reaching a value corresponding to a sound level indicative that sawing by the machine has been completed.

Methods according to the invention and apparatus embodying the invention, both for controlling wood sawing machines, will now be more particularly described, by way of example, with reference to the accompanying drawings, in which Figure 1 and 2 are circuit diagrams of respective forms of the control apparatus.

Certain known wood sawing machines comprise a band saw or a circular saw mounted in a fixed position and a carriage capable of being displaced on the side of the active run of the saw; for this purpose the carriage is guided along a track and is connected to a driving device imparting a reciprocating longitudinal translational movement to the carriage. This carriage supports brackets which are movable transversely along slides of the carriage and are provided with means (such as claws) for gripping a piece of wood to be sawn. The brackets are connected to a synchronous translational driving device making it possible to effect successive advances of the piece of wood towards the saw of a magnitude depending on the desired thickness of the products to be produced by sawing and (depending on the type of saw) also to effect withdrawal of the wood piece to avoid meeting the saw during a longitudinal return movement of

the carriage.

With such sawing machines, it is required to stop the carriage as soon as the sawing operation is ended and if the saw comprises two opposite sets of teeth, to initiate movement in the opposite direction after having effected a transverse advance or, if the saw has only one set of teeth, a transverse withdrawal to avoid the saw during carriage return.

In the methods and apparatus to be described, initiation of the transverse movements of the carriage slides and of the longitudinal movement of the carriage is effected in response to detection of completion (and where appropriate, commencement) of sawing as sensed by the change in sound produced by the saw between a sawing and a non-sawing state.

To this end, the control apparatus for the wood sawing machine has a sound detector arranged in the vicinity of the saw to monitor sound generated by the saw during idling and sawing, and also includes circuitry receiving the output of the detector and arranged to generate a monitored-sound signal indicative of the magnitude of at least one frequency component of the sound emitted by the saw. The apparatus is further arranged to generate a completion signal upon detection of a change in magnitude of the monitored-sound signal corresponding to completion of sawing. The apparatus may also be arranged to produce a commencement signal upon detection of a change in the magnitude of the monitored-sound signal corresponding to commencement of sawing.

When the saw is a band saw having a single set of teeth, or a circular saw, a fixed position for the commencement of sawing may be chosen for the piece of wood. In this case it is necessary to make sure that the setting of the piece of wood on the carrying brackets of the carriage is correct, that is, that for the sawing commencement position of the carriage the end of this piece at which sawing is to commence is situated in front of the saw and as close to the saw as possible. The control apparatus is required only to generate a completion signal upon detection that sawing is completed; this control signal is then effective to control the sawing machine such that the carriage is stopped, the carrying brackets are withdrawn transversely to move the piece of wood away from the saw, and the carriage is started for its displacement in the opposite direction. The sawing machine is so arranged that the carriage will stop automatically on its return run when the fixed position for the commencement of sawing is reached; the brackets carrying the piece of wood are then advanced transversely and the carriage begins a new sawing movement.

In the case of a band saw having a single set of teeth or of a circular saw, it is also possible to determine the sawing commencement position in accordance with the length of the piece of wood, by arranging for the control apparatus to generate not only a completion signal upon completion of sawing but also a commencement signal as soon as sawing commences. The control apparatus is also arranged to memorise the displacement of the carriage which takes place between the commencement and completion signals and, when the completion signal has initiated the carriage return as described in the preceding case, the control apparatus brings about stopping of the carriage as soon as its return displacement becomes equal to its displacement during the sawing operation; the operations of transverse advance of the support brackets and the starting of a new sawing movement follow in sequence.

If the wood sawing machine uses a band saw with two opposite sets of teeth, it is only necessary that the control apparatus should generate the completion signal for stopping the carriage, effecting a transverse advance of the support brackets and starting the said carriage for a sawing movement in the opposite direction.

Generally, sawing machines co-operate with subsequent handling devices arranged to operate only when sawing is in fact completed. In such cases, the control apparatus is arranged to generate both commencement and completion signals, the commencement signal being utilised to render the handling devices inoperative. To initiate operation of these devices when sawing is complete it is possible either to use the commencement signal for starting a clockwork timer or other timing mechanism, which emits a signal for activation of the handling devices when a preselected sawing time has elapsed, or to use the completion signal for reactivating the handling devices.

Two forms of the control apparatus will now be described.

The form of control apparatus shown in Figure 1 is arranged to generate both a commencement and a completion signal and depends on changes in the average magnitude of sound of all frequencies detected between a sawing and sawing completed condition. This form of apparatus is suitable for sawing machiness in which the magnitude of noise generated during sawing is detectably greater than otherwise. The apparatus comprises an acoustic detector 1, such as a microphone, the output signal from which is fed via a transformer 2 to an amplifier stage formed by a transistor 3. The amplified signal is then rectified by a diode 4 and smoothed by a condenser 5 to give a voltage the magnitude of which depends on the strength of the detected audio signal; this voltage constitutes a monitored-sound

signal and is applied to the control electrode of a thyristor 6 connected to the output of a rectangular waveform current signal generator 7. The thyristor 6 is connected in series with a winding 8 of a relay arranged to output, when energise, the commencement signal. The series combination of the thyristor 6 and the winding 8 is connected in parallel with a winding 9 of a relay arranged to output, when energised, the completion signal. Both windings 8 and 9 are paralleled by respective protection diodes. When a loud audio signal is detected, during the sawing period, the voltage fed to the control electrode of the thyristor 6 is high and the thyristor becomes conductive and the winding 8 is supplied with current sufficient to activate the corresponding relay and generate the commencement signal. On the other hand, when the signal is weak or when there is no signal the thyristor 6 is blocked: all of the current of the generator 7 then passes through the winding 9, causing actuation of the corresponding relay to generate the completion signal. During conduction of the thyristor 6 the current through the winding 9 is insufficient to actuate the corresponding relay.

Experience has shown that between the level of noise of sawing and the level of noise of the saw running idly there is often only a slight difference in the overall noise, which does not always make it possible to differentiate clearly between the two levels. However, these two noises are in fact made up of components of various frequencies and it has been found that above 8000 Hz there is a considerable difference between the sawing noise and the noise of the saw running idly. To facilitate detection it is therefore advantageous to take account only of those frequency components of the detected signal which are higher than 8000 Hz. An alternative embodied in the second form of control apparatus to be described hereinafter, is to select a particular frequency component rather than a range of frequencies, the magnitude of which is to be used to control generation of the commencement and completion signals.

In the second form of the control apparatus (Figure 2) the output of the acoustic detector 1 is fed via an impedance transformer 2 to a pre-amplifying circuit 10 and then to a power amplifying circuit 11. The resultant amplified signal is fed to an output transformer 12. The amplified signal contains components of different frequencies. By using the selector switch 13 to choose one of a range of condensers (the first three of which are referenced 14, 14*a* and 14*b* in Figure 2) a particular frequency component can be selected whose magnitude is to effect control of generation of the completion and commencement signals. The chosen capacitor and the secondary winding of the transformer 12 form, together with a condenser 15 connected to a positive voltage rail, a tuned circuit which is connected to the control electrode of the thyristor 6. The thyristor 6 is connected in series with the winding 8 of a relay across the output of the generator 7. Upon the magnitude of the signal present in the tuned circuit (the monitored-sound signal) reaching a critical value, the thyritor 6 will be triggered into conduction to energise the winding 8 and activate the relay to generate the commencement signal. In its at rest state the relay is arranged to generate the completion signal.

The hereinbefore described methods and apparatus are advantageous in that they enable more efficient movement of the carriage and do not require mechanical sensors to detect completion of sawing.

Although the hereinbefore described methods and apparatus are discussed in relation to wood sawing machines, the methods and apparatus can also be used in other sawing machines, for example for sawing stone, plastics or metal.

WHAT WE CLAIM IS:—

1. A method of controlling a sawing machine including monitoring the sound generated by the sawing machine during idling and sawing and generating a monitored-sound signal of a magnitude indicative of the magnitude of at least one frequency component of the sound monitored, generating a completion signal upon the magnitude of the said monitored-sound signal becoming equal to a value indicative that sawing by the machine has been completed, and utilising said completion signal to control movement of a workpiece relative to a saw blade of the machine.

2. A method according to claim 1, in which the movement of a carriage feeding the workpiece past the saw blade is stopped immediately upon generation of the said completion signal and then elements of the carriage carrying the workpiece are transversely advanced or withdrawn, this transverse movement being followed by the starting of movement of the carriage in a reverse direction to its preceding movement direction.

3. A method according to claim 2 and applicable to a sawing machine cutting always in the same direction of movement of the carriage, the method further comprising generating a commencement signal upon the magnitude of the said monitored-sound signal becoming equal to a value indicative that sawing by the machine is beginning, memorizing the linear displacement of the carriage during the sawing operation between the starts of the commencement and completion signals, and controlling move-

ment of carriage in the said reverse direction such that its displacement in the reverse direction is equal to the memorised linear displacement.

4. A method according to claim 2, further including generating a commencement signal upon the magnitude of the said monitored-sound signal becoming equal to a value indicative that sawing by the machine is beginning, utilising said commencement signal to control handling devices for sawn pieces in order to render these devices inactive, and re-activating the handling devices either after a predetermined time delay or upon generation of the said completion signal.

5. A method according to any one of the preceding claims, in which the magnitude of the said monitored-sound signal is indicative of the average magnitude of sound of all frequencies generated by the sawing machine.

6. A method according to any one of claims 1 to 4, in which the magnitude of the said monitored-sound signal is indicative of the average magnitude of sound frequency components in a predetermined range of frequencies.

7. A method according to claim 6, in which the said range of frequencies has a lower frequency limit of 8000 Hz.

8. A method according to any one of claims 1 to 4, in which the magnitude of the said monitored-sound signal is indicative of the magnitude of a preselected frequency component of the sound generated by the sawing machine.

9. A method according to claim 5 when dependent on claim 3 or claim 4, in which the sound generated by the sawing machine is monitored by an electro-acoustic transducer the electrical output signal of which, after amplification, rectification and smoothing, constitutes said monitored-sound signal, the monitored-sound signal being used to control a thyristor of a circuit arranged to generate the completion signal and the commencement signal.

10. A method according to claim 10, in which the said circuit includes a series combination of a first relay and the thyristor, and a second relay connected in parallel with the said series combination, the arrangement of the circuit being such that the first and second relays are actuated respectively during conduction and non-conduction of the thyristor to generate the completion and commencement signals.

11. A method according to claim 8, in which the sound generated by the sawing machine is monitored by an electro-acoustic transducer the electrical output signal of which is, after amplification, filtered in order to select the desired said frequency component, the filtered signal constituting the said monitored-sound signal.

12. A method according to claim 11, in that the amplified and filtered signal is used to control a thyristor arranged to actuate a relay when triggered into conduction, said relay being arranged to generate the completion signal when actuated.

13. A method according to any one of claims 9, 10 and 12, in which the circuit into which the thyristor is connected is fed with current of rectangular waveform enabling thereby the de-activation of the thyristor in the absence of a signal rendering the thyristor conductive.

14. A method of controlling a sawing machine, substantially as hereinbefore described with reference to Figs. 1 or Fig. 2 of the accompanying drawings.

15. Apparatus for controlling a sawing machine including sound monitoring means for generating an electrical signal of a magnitude indicative of the magnitude of at least one frequency component of sound generated by the sawing machine during idling and sawing, and completion-signal generating means for generating a completion signal upon the magnitude of the said electrical signal reaching a value corresponding to a sound level indicative that sawing by the machine has been completed.

16. Apparatus for controlling a sawing machine, substantially as hereinbefore described with reference to Figure 1 or Figure 2 of the accompanying drawings.

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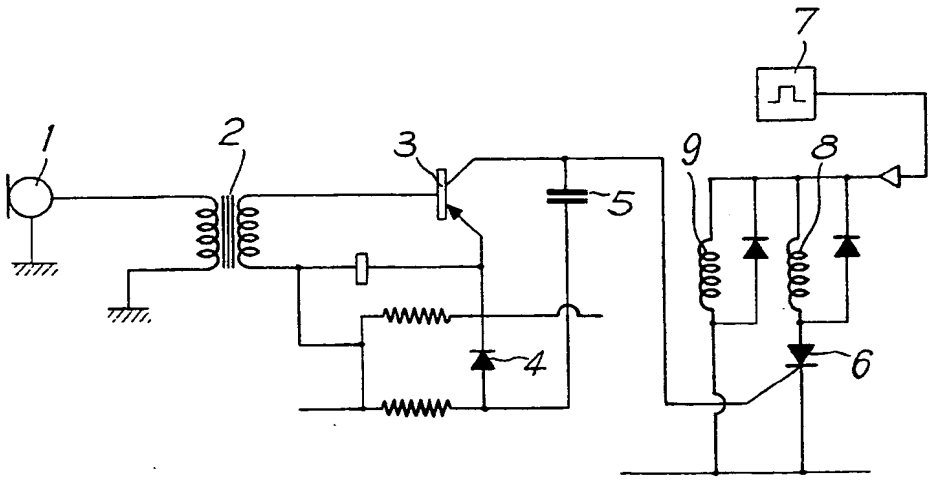
2 SHEETS

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

Fig. 1



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2 SHEETS

COMPLETE SPECIFICATION

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SHEET 2

FIG. 2